COMPUTATION OF MANY MODES OF LARGE STRUCTURAL SYSTEMS USING SALINAS[1]

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The need for predictive, qualified models of very complex structures drives the requirements for large scale structural analysis. Because eigenanalysis provides a basis for many modal based solution methods (such as frequency response, transient dynamics and modal damping), it is a convenient and useful method for analysis of these large systems. However, as the model size and demands for higher frequency content grow, the challenge of computing a large eigenspace can be significant. One approach is to combine an iterative Lanczos eigen driver with an iterative domain decomposition based solver.

The finite element package, *Salinas*, employs an eigensolver based on *arpack*[2] driving a FETI-DP[3] linear solver. We address issues related to accuracy of the solution when thousands of modes are computed. Performance and scalability on massively parallel platforms are presented.

First, we investigate the scalability and performance of Salinas on ASCI Q. We calculate modal frequencies on a simple cube model that grows in problem size as we use more processors. Performance data for Salinas running on 64 up to 1000 processors of ASCI Q is presented. We discuss the scalability and performance issues related to eigenanalysis using Salinas.

In addition, two complex, real world case studies are considered. A reentry body (RB), is analyzed on an IBM SP platform, where 6000 eigenmodes are computed. The dependence of the modal frequencies on solver accuracy is examined. We observe an approximately constant eigenvalue modal density through this spectrum.

Our second example is a moderate sized (~ 5 million equation) model of an aircraft carrier. The structural model is significantly different, consisting almost entirely of shells stiffened by offset beams. The eigenvalue modal density is compared along with the reported Ritz values and their residuals.

These two examples illustrate the results generally obtained using this eigensolver method on large models. Extremely high accuracy linear solves are not generally required in order to maintain convergence of the eigensolver. Except for anomalies near the end of the eigenspectrum, the eigenvalue accuracy computed by *arpack* using an iterative linear solver appears to be good, and the results repeatable.

References

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[2] R. B. Lehoucq, D.C. Sorensen, P.A. Vu and C. Yang. *ARPACK: Fortran subroutines for solving large scale eigenvalue problems*, Release 2.1

[3] C. Farhat, M. Lesoinne, P. Le Tallec, K. Pierson, and D.Rixen. *FETI-DP: A dual-primal unified FETI method - part I: A faster alternative to the two-level FETI method*. Int. J. Numer. Meth. Engrg., 50:1523-1544, 2001.

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